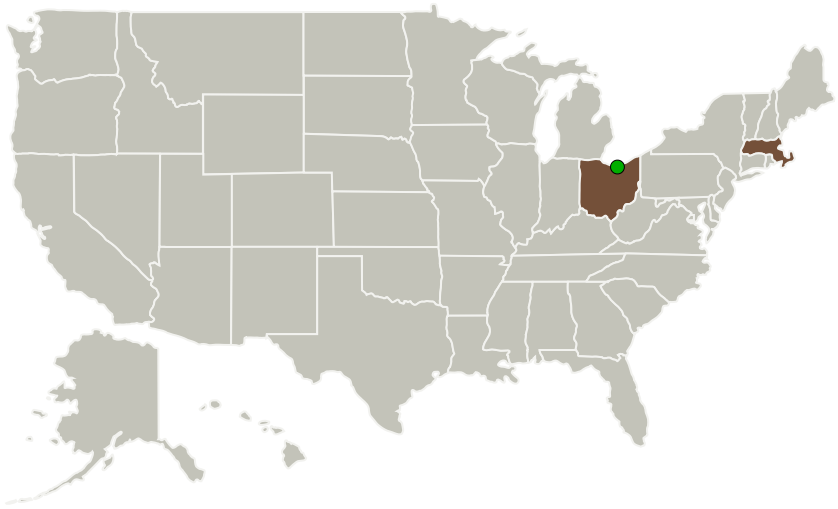
Space Suit Simulator (S3) for Partial Gravity EVA Experimentation and Training, Phase II

Completed Technology Project (2011 - 2013)

Project Introduction

Pressurized space suits impose high joint torques on the wearer, reducing mobility for upper and lower body motions. Using actual space suits in training or experimentation is problematic due to the expense, bulk, weight, and difficulty in donning/doffing. The goal of this project was to demonstrate a novel method for simulating space suit joint torques, which are non-linear and vary with angular position. We designed a knee joint simulator using McKibben actuators with active control (also known as artificial muscles), which are cylindrical pneumatic actuators constructed of flexible rubber with an inextensible weave that causes the cylinder to contract longitudinally when pressurized. A commercial knee brace was used as an exoskeleton to mount the actuators. One actuator was mounted anterior to the knee to provide resistance to flexion, and a second actuator was mounted posterior to the knee to provide resistance to extension. The active controller read angle input from a potentiometer mounted to the brace and output the appropriate pressures for each actuator to provide the needed torque. The knee joint was installed on MIT's Robotic Space Suit Tester (RSST), a full-sized anthropometric robot equipped with torque and angle sensors on each of the joints. Results from testing indicated that the torque vs. angle relationship achieved using the actively controlled spacesuit joint simulator was qualitatively similar to the non-linear trend observed in prior testing of the EMU on the RSST. We conclude that the use of these actuators potentially results in higher fidelity than passive actuation.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Massachusetts	Ohio

Project Transitions

June 2011: Project Start

May 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139480)*

Project Management

Program Director:

Jason L Kessler

Program Manager:

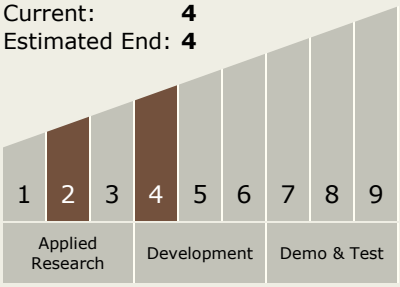
Carlos Torrez

Principal Investigator:

Jessica Duda

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.2 Prevention and Countermeasures

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Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System